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CARBON MONOXIDE LASER
SEMI-ANNUAL TECHNICAL REPORT
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Principal Investigator: Dr. M. L. Bhaumik
Tel: (213) 675-4611,
Extension 4825

Scientific Officer
Director, Physics Programs
Physical Sciences Division
Office of Naval Research
Department of the Navy
Arlington, Virginia 22217

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NORTHROP CORPORATE LABORATORIES
3401 West Broadway
Hawthorne, California 90250

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In this reporting period, the small signal gain coefficient and spectral characteristics of an electrically excited room-temperature CO laser have been investigated for the purpose of understanding the role of the necessary gas constituents and the possible excitation mechanisms involved.

The room temperature operation is possible only with higher partial pressures of the major constituents as compared to those at 77°K. The need for a higher partial pressure of CO at 20°C seems to be simply to compensate for the reduction in gain with increasing temperatures. A 6:1 ratio of N_2 to CO is also found to be necessary, while the optimum ratio at 77°K is nearly 1:1. The higher ratio of N_2 at 20°C seems to be needed primarily to shield the CO molecules against decomposition by collision with highly energetic electrons. The oxygen concentration necessary for room-temperature operation of the CO laser is critical since any excess of oxygen would help form an undesirable amount of CO_2.

The typical output spectrum of the CO laser at 20°C is given in Table I. The higher quantum numbers of the rotational lines, as compared to those observed at 77°K, are consistent with the theory of a molecular laser. The disappearance of the lower vibrational bands below the 9-8 band is a special feature of the room temperature operation. Since the vibrational temperatures are not expected to change drastically with the molecular kinetic temperature, the vibrational bands 6-5, 7-6, 8-7 which are present at 77°K should normally be expected at room temperature. This discrepancy may be explained in terms of the anharmonic decoupling, which seems to be a characteristic of a diatomic molecular laser with small anharmonicity.

The appearance of more than one rotational line in any particular vibrational band is a result of cascading. This is clearly established by a study of the time resolved spectroscopy of the CO laser. The gradual decrease of the rotational quantum number with increasing vibrational quantum number also lends support to cascading.

The preliminary results of gain measurements of the optimum mixture for the room temperature CO laser has been obtained. The small signal gain for the strongest line in the absence of cascading has been measured to be 15% per meter. The actual gain in the presence of cascading must be higher, since the optimum coupling necessary for room temperature operation of a laser with a one meter discharge tube is nearly 15%.

The gain measurement and the spectral studies are being continued for the various lines and at different temperatures. Plans are being made for the measurement of vibrational relaxation rates.

TABLE I - SPECTRAL OUTPUT (IN μm) OF CO LASER AT 20°C

λ Obs. (Air)	λ Theo. (Air)	ν cm^{-1}	Vibrational Band	Transition	Rel. Intensity
5.3155	5.3152	1880.897	8-7	P(20)	80
5.3275	5.3273	1876.629		P(21)	9
5.3397	5.3395	1872.329		P(22)	10
5.3871	5.3876	1855.615	9-8	P(20)	100
5.3993	5.3999	1851.382		P(21)	16
		1842.821	10-9	P(17)	
5.4487	5.4494	1834.577		P(19)	52
5.5131	5.5127	1813.514	11-10	P(18)	17
5.5256	5.5252	1089.416		P(19)	1.8
5.5901	5.5901	1788.398	12-11	P(18)	2.2
5.6027	5.6028	1784.334		P(19)	0.9
5.6559	5.6567	1767.359	13-12	P(17)	0.3
5.6688	5.6695	1763.363		P(18)	0.5
5.6819	5.6825	1759.334		P(19)	--
5.6991	5.6996	1754.060	14-13	P(14)	0.3

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